AbstractID: 10902 Title: Development and testing of a novel, 4D Maximum A Posteriori (MAP) image reconstruction algorithm

Purpose: Deformable image registration has been proven to be useful in tracking organ motion for dose calculation using artifact-free 4D RCCT images. Such methods are challenged in the presence of image artifacts. We present an alternative method which avoids binning artifacts by directly estimating organ deformation during the reconstruction process.

Method and Materials: We have developed a maximum a posteriori (MAP) algorithm for tracking organ motion that uses raw time-stamped data to reconstruct the images and estimate deformations in anatomy simultaneously. Since the algorithm does not rely on a binning process, binning artifacts are avoided. Signal-to-noise ratio (SNR) is also increased since the algorithm uses all of the collected data. The increased SNR provides the opportunity to reduce dose to the patient during scanning. This framework also facilitates the incorporation of fundamental physical properties such as the conservation of local tissue volume during the estimation of organ motion.

In order to validate the accuracy of the 4D reconstruction algorithm, a phantom study was performed using the CIRS anthropomorphic thorax phantom in a CT scanner. An improvement in image quality was also demonstrated by application of the algorithm to data from a real liver stereotactic body radiation therapy (SBRT) patient.

Results: The algorithm accurately estimated the known motion of the anthropomorphic phantom. Additionally, a significant SNR increase was observed when using 4D reconstruction over binning, even for a scan with X-ray tube current reduced to 10%.

Conclusion: A novel method of fully 4D CT reconstruction was presented. The geometric accuracy of the estimated deformation was validated in phantom. A marked improvement in image quality was observed when applying the algorithm to image data from a real liver SBRT patient. The method allows reduction of X-ray tube current during scanning while simultaneously improving motion estimates for use in dose calculation.